

CD-Doc-2344

ILC Detector R&D in CD: An Overview

Rob Kutschke, CD/IDS
ILC Coordination Forum
July 17, 2007

Agenda

Title	Presenter	Time (min)
Overview	Rob Kutschke	15
SiD Simulations and Benchmarking	Rob Kutschke	15
SiD Forward Tracking	Hans Wenzel	15
Progress and Plans	G.P. Yeh	15
Hardware Acquisition Plans	Lynn Garren	15
IDS Roadmap (maybe)	Mark Fischler	15

Adam Para is on vacation.

ILC Detector Work at FNAL

- R&D for vertex detector and tracking hardware.
 - Marcel Demarteau, Ron Lipton, Bill Cooper
- Muon detector design and physics with muons
 - Gene Fisk, Caroline Milstene
- Physics Benchmarks
 - Aurelio Juste, Rob Kutschke, John Yoh
- SiD Detector Simulations
 - Lynn Garren, Mark Fischler, Rob Kutschke, Hans Wenzel
- Calorimetry: Tech Review, Pb-Scint Dual Readout.
 - Adam Para, Hans Wenzel
- 4th concept
 - G.P. Yeh

This ILC Forum is about work by names in red

External Drivers

- ILC descoped to one IR (10% \$ savings).
- Two detectors retained:
 - Redundancy, competition.
 - Push-pull. Goal: switch-over O(1 week)!!!!!!
 - Ideally optimized for different physics scenarios !!!!
- The ILCSC asked WWS co-chairs to develop a “detector roadmap”. link????
 - Delayed decisions can jeopardize the project.
 - Insufficient resources to keep all options on the table for all detector concepts to completion of TDRs.
 - Aggressively reduce duplicated effort.
 - Down select earlier if that is not enough.
 - Goal: Detector TDRs in 2010 (machine TDR time).

The Detector Roadmap

- 2010: detector design must be at a “similar stage of maturity” to that of the accelerator.
- Timeline:
 - Fall 2008: CDRs from all detector concepts.
 - Concept \neq Collaboration
 - Down-select to 2 detectors.
 - Form official detector collaborations at this time.
 - Must get this part right!
 - Retain options!
 - Reduce funding for low priority ideas/options!
 - Fall 2010: TDRs due.
 - Ready to build by 2012.
- Background hope: self-merging before down-select.

International Detector Advisory Group

- ILCSC would like to form an “International Detector Advisory Group” (IDAG)
- I am not 100% clear what this is:
 - Will push the roadmap.
 - Will provide a single point of contact, representing detectors to the GDE.
 - Probably less than a GDE for detectors.

Inconvenient Truths

- By fall 2008, R&D will not produce a clear choice among the competing options.
 - Not even by 2010!
- ILC community will not have resources to do a real TDR, even for one detector, by 2010!
- Imaginary deadlines are a useful management tool but they can also hurt us:
 - NASA is now launching satellites with technology frozen 20 years ago.

My View

- Roadmap and IDAG will happen.
- to set a significant milestone for 2010.
 - Long enough for significant work to be done.
 - Need to have an up to date response if there is a discovery at the LHC or TeV.
- It won't really be a true TDR since we won't get the resources to do it.
 - It will be a snapshot of the technical design process.
 - It can be “at the same level as that of the machine”.
 - I prefer not to call it a TDR but ...
- Key is to be smart about retaining/rejecting options.
appropriate options at down-select.

Relevant Deadlines

- ALCPG October 22-26, 2007 at FNAL
 - Major status report.
 - Bonus points for showing the flag.
- Spring 2008
 - Software for CDR benchmarks essentially complete.
 - CDR benchmark studies underway.
 - Start writing CDR.
- Fall 2008
 - Submit CDR.

World-Wide Detector Picture

Detector Concepts (July 2007)

- **SiD**
 - US based. All silicon tracking. PFA calorimetry.
- **GDC/LDC**
 - Merged just before DESY meeting:
 - GDC: Global Large Detector. Asian based.
 - LDC: Large Detector Concept. European based.
 - Pixel Vertex/TPC tracking/PFA calorimetry.
- **4TH Concept**
 - DREAM CAL (Dual REAdout Modules).
 - Considering all tracking options.
 - By far the smallest group.
 - At Argonne told they are too small to survive on their own.
 - Some suggest their calorimeter become an option on SiD.

Comparing Detectors

Detector	Vertex Detector	Tracking System	ECAL	HCAL	Muon/Tail Catcher
SiD	Si Pixels	Si Strips	VV/Si-Pixels		
GDC/LDC	Si Pixels	TPC			
4th	Si Pixels	TPC/ CLUCOU/ Si Strips	Dual Readout (DREAM)		

Finish this page!!!

World Wide Software Status (I)

- I have personally only run SiD software.
 - Some reconstruction code that SiD says works, actually ran in an NLC-era framework and has never been ported to the new one.
 - My perception is that LDC is more advanced.
- 4 Detector concepts
 - 4 Frameworks and 4 build environments.
- Efforts at standardization between SiD and LDC:
 - LCIO: event IO.
 - LCDD: geometry description.
 - Both are incomplete (details in backup slides).
 - Others groups would like to join these efforts but it is a low priority.

World Wide Software Status (2)

- Goal: highly interchangeable data
 - Run event generator in framework A, detector simulation in framework B, reconstruction in framework C and analysis in framework D.
- I view this as just silly.
 - Doable for toy detectors, not realistic ones.
 - A much more limited version makes sense
 - Exchange stdhep files and reconstructed objects, neither of which depends much on internal details of the detector.
- Someone has actually run their PFA on both SiD and LDC events.
 - Check with Norman. Who. How toy/real?

The IDS Team at FNAL/CD

Lynn Garren	System admin; software deployment, maintenance and development; web site development.
Mark Fischler	Planning and oversight.
Rob Kutschke	Tracking and vertexing reconstruction software; benchmark analysis.
Adam Para	Calorimeter technology survey. R&D into Pb-Scint cal.
Hans Wenzel	SiD forward tracking software: Sim and reconstruction. Implement Pb-Scint in SLIC.
G.P.Yeh	4th concept.
Summer Students:	
Francisco Ruiz	FNAL, IPN Mexico; working with Hans on tracking.
Daniele Barbareschi	INFN Lecce (4th concept) paid by PPD; working with Hans on tracking.
Related people:	
Caroline Milstene	PPD finishing papers on physics with muons. Plus a summer student.

The Next Talks

- Rob
 - SiD detector and software.
 - Jobs we plan to do.
 - Details on SiD work not covered in Hans' talks.
- Hans
 - Details on SiD forward tracking
 - Implementation of Pb-scint calorimeter in SLIC
- G.P.
 - Progress and Plans on 4th concept.
- Lynn
 - Why we need more computing resources
- Mark

Summary

- Detector roadmap and IDAG will be adopted.
- We are down to 3 detector concepts.
 - Some suggest SiD and 4th merge?
- Lots of software, lots of duplication, little coherence.
 - Some silly ideas.
- Deadlines
 - October/07: ILC workshop at FNAL
 - Spring 08: Major s/w R&D complete
 - Fall/08: Submit CDR

Backup Slides

Some Detector Challenges

- Jet energy resolution:
 - Separate $W \rightarrow \text{jet jet}$ from $Z \rightarrow \text{jet jet}$.
 - $\sigma(m(\text{jet jet})) < 3 \text{ or } 4 \text{ GeV}$, independent of $E(\text{jet jet})$.
 - Often specified as $\sigma(E)/E \leq 30\%/\sqrt{E}$ or as flat $\leq 3\%$. **Check**
- Momentum resolution:
 - Resolve a very narrow, low mass $H \rightarrow \mu\mu$.
 - $\sigma(pT)/pT \leq 2 \times 10^{-5}$ **Check number and units.**
- Extend both of the above farther in to the forward region than ever before.
- Robust against enormous background from beamstrahlung.

Calorimetry Concepts

- Particle Flow Analysis
 - Fine lateral and transverse segmentation $O(1 \text{ cm}^3)$.
 - Within each jet, assign each hit to: charged track, EM shower, neutral hadron shower.
 - Jet energy = sum of
 - Charged tracks, measured in tracking system
 - + EM energy, measured in ECAL.
 - + Neutral hadron energy, measured in HCAL.
- Dual Readout:
 - Measure both scintillation and Čerenkov light.
 - Untangle EM and hadronic components on a jet by jet basis. Apply separate calibrations to EM and hadronic.
- Neither fully proven.

World Wide Software Status

- 4 Detector concepts
 - 4 frameworks and 4 build environments.
 - Frameworks: Two C++; one Java; one root based.
 - Evolved from legacy NLC, JLC ...
 - All use can G4 for simulations (GHEISHA/FLUKA?)
- Geometry
 - Everyone has their own tool to digest a geometry description to feed G4 and their own reco code.
 - LCDD:
 - Linear Collider Detector Description.
 - Can be digested by both Europeans and SiD.
 - Others have talked about joining.
 - Only geometry, not material properties.
 - Extension to include material properties promised.
 - Time scale not known.

World Wide Software Status (2)

- LCIO:
 - Joint effort by SLAC and Europeans for event IO.
 - Asians and 4th have talked about coming on board.
 - APIs for Java, C++, Fortran.
 - Weaknesses:
 - No schema evolution.
 - Persistent classes are not very functional for tracking.
 - Crashes if it reads an unrecognized block.
 - Fixed in a recent release that I have not yet tried.
 - No provenance.
 - Collection names free form. No enforced conventions.
 - Bi-directional relations between objects.
 - Coming: new version (root-io back end?).
 - Time scale not known.

World Wide Software Status (3)

- LCFI
 - Linear Collider Flavor Initiative
 - Code to flavor tag jet using vertexing and leptons-in-jets.
 - C++ only but concept agnostic.
 - Hope to use in SiD by writing jets to LCIO files and running code in its native environment.

Magic Words and Phrases

- **ILCSC:** ILC Steering Committee
 - An adhoc body with influence but no money.
- **WWS:** World Wide Study
- **CDR:** Conceptual Design Report
 - Due Fall 2008.
- **DCR:** Detector Concept Report
 - An attachment to the RDR.
- **TDR:** Technical Design Report
- **RDR:** Reference Design Report
 - The design document for the Accelerator that was released in Beijing. Review is complete about now.
- **PFA:** Particle Flow Analysis

Magic Words and Phrases

- **Dual Readout Calorimetry**
 - Another calorimetry concept.
- **DREAM**
 - Dual REAout Module,
- **IDS:** ILC Detector Simulations (our group in CD).
- **IDAG:** International Detector Advisory Group